

USSR/Physics - Magnetism  
Anisotropy

11 Dec 49

"Calculation of the Second Constant of Magnetic Anisotropy by Approximation to Saturation," L. V. Kirenskiy, L. I. Slobodskoy, Krasnoyarsk Pedagogical Inst, Krasnoyarsk, 4 pp

"Dok Ak Nauk SSSR" Vol LXIX, No 5 - pp. 634-42

Intensity  $I$  of magnetization for strong magnetic fields of strength  $H$  can be expressed thus:

$I = I_0(1 - a/H - b/H^2 - c/H^3) + \chi_p H$  (for given temperature) where  $I_0$  is the intensity of spontaneous magnetization,  $\chi_p$  is the susceptibility of the para-process,

USSR/Physics - Magnetism  
(Contd)

11 Dec 49

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and the coefficient  $a$  depends on plastic deformation. This work deals with theoretical calculation of the coefficients  $b$  and  $c$  as functions of the second constant  $k_2$  of magnetic anisotropy, in addition to the first energy constant  $k_1$ , as given previously for only  $b$ . Constants of anisotropy depend essentially on temperature, e.g., in the case of nickel at low temperatures the term  $c/H^3$  becomes important because of the strong increase in  $k_1$  with decreasing temperatures. Submitted by Acad D. V. Skobel'tsyn 21 Sep 49.

152191

KIRENSKIY, L. V.

Doc Physicomath Sci

KIRENSKIY, L. V.

Dissertation: "Investigation of the Energetic Anisotropy of Ferromagnetic Materials."

6/12/50


Moscow Order of Lenin State U imeni

M. V. Lomonosov

SO Vecheryaya Moskva  
Sum 71

KIRENSKIY, L. V.

\*The Influence of Elastic Internal Stresses on the Law of Approach to Magnetic Saturation. L. V. Kirenskiy and L. I. Kobchakov (*Doklady Akad. Nauk S.S.S.R.*, 1972, 70, (6), 800-811).—[In Russian]. A calculation of the intensity of magnetization of polycryst. aggregates at high field strength, taking into account the magnetostrictive effect, is given. The internal stresses present in the sample are shown to alter the shape of the magnetization curve at high field strengths to a significant extent at room temp. The shape of the curve can indicate whether the original stresses are opposing or relieving those set up by magnetostriction.  
—Z. S. B.



KIRENSKIY, L. V.

PA 174159

USSR/Physics - Nickel  
Anisotropy

11 Sep 50

"Energy Anisotropy of Nickel," L. V. Kirenskiy,  
Krasnoyarsk State Pedagogical Inst

"Dok Ak Nauk SSSR" Vol LXXIV, No 2, pp 209-211

Dependence of  $\log k_1$  upon  $T^2$  (where  $k_1$  is 1st  
const of anisotropy, etc.);  $k_1$  varies  $80 \cdot 10^4$  -  
0 as  $T$  varies 0 - 600°K. Dependence of  $k_2$  upon  
 $T$  (roughly same as  $k_1$  vs  $T$ ). Relation of energy

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USSR/Physics - Nickel (Contd)

11 Sep 50

$m$  to  $k$ 's and angles ( $s_1, s_2, s_3$ ) of nickel crys-  
tal given in analytical form. Submitted 10 Jul  
50 by S. I. Vavilov.

174159

KIRENSKIY, L. V.

PA 174T71

USSR/Physics - Magnetism

21 Sep 50

"Influence of Directed Stresses Upon the Behavior of the Magnetization Curve in Strong Fields," L. V. Kirenskiy, L. I. Slobodskoy, Krasnoyarsk Pedagogical Inst

"Dok Ak Nauk SSSR" Vol LXXIV, No 3, pp 457-459

Considers  $I = I_s(1 - a/H - b/H^2 - c/H^3) - \chi H$ . Math treatment in connection with caln of law governing approximation to saturation in presence of directed elastic stresses. Submitted 10 Jul 50 by Acad S. I. Vavilov.

174T71

178786

KIRENSKIY, L. V.

USSR/Metals - Ferromagnetics

21 Jan 51

"Phenomenon of Reverse Inversion in Ferromagnetics," L. V. Kirenskiy, V. F. Ivlev, Krasnoyarsk State Pedagogical Inst

"Dok Ak Nauk SSSR" Vol LXXVI, No 3, pp 389-391

Subject inversion process involves shift or transposition of interdomain partition under action of magnetic fld. Here magnetization intensity vector increases with growth of fld as long as that phase increases whose spins are oriented in direction of axis of least magnetization closest to direction of fld. Submitted 20 Nov 50 by Acad S. I. Vavilov.

178786

KIRENSKIY, L. V., VLASOV, A. YA.

Thermomagnetism

Temperature hysteresis of magnetostriction. Izv. AN SSSR Ser. fiz. 16, No. 6, 1952.

Assumes that temperature hysteresis occurs not only in temperature magnetisation curves, but also in temp curves of even effects, particularly magnetostriction. Attempts exptl proof, namely by studying variations of magnetostriction at ~~next~~ various temps and plotting corresponding curves.

251T38

Monthly List of Russian Accessions, Library of Congress  
June 1953. UNCL.

~~KIRENSKIY, Leonid Vasil'yevich~~, doktor fiziko-matematicheskikh nauk;  
DROKIN, Aleksandr Ivanovich, kandidat fiziko-matematicheskikh  
nauk; LIFSHITS, L., redaktor; KOKOULINA, A., tekhnicheskii re-  
daktor.

[Atomic energy and its utilization] Atomnaya energiya i ee primeneniye.  
[Krasnoyarsk] Krasnoyarskoe knizhnoe izd-vo 1955. 46 p. [Microfilm]  
(MIRA 10:5)

(Atomic power)

KIRENSKIY, L. V., DYLGEROV, V. L., SAVCHENKO, M. K., (Krasnoyarsk)

"The Dynamics of the Domain structure in the Silicon-Iron Crystals,"  
a paper submitted at the International Conference on Physics of Magnetic  
Phenomena, Sverdlovsk, 23-31 May 56.

KIRENSKIY, L. V., NOSOVA, R. S. and RESHETNIKOVA, N. V. (Krasnoyarsk)

"The Temperature Dependence of the Magnetic Properties of Ni," paper  
presented at the International Conference on Physics of Magnetic Phenomena,  
Sverdlovsk, USSR, 23-31 May 1956.

KIRENSKIY, L. V., VLASOV, A. I., VTYURIN, N. I., DROKYN, A. I., IVLEV, V. F.,  
TURKALOV, R. I., (Krasnoyarsk)

"The Temperature and Rotation Hysteresis in Ferromagnetic Materials,"  
a paper submitted at the International Conference on Physics of Magnetic  
Phenomena, Sverdlovsk, 23-31 May 56.

USSR/Magnetism - Ferromagnetism

F-4

Abs Jour : Referat Zhur - Fizika, No 5, 1957, 11995

Author : Kirenskiy, L.V., Ivlev, V.F.

Inst : Krasnoyarsk Pedagogical Institute, USSR.

Title : Temperature Hysteresis of the Galvanomagnetic Effect.

Orig Pub : Dokl. AN SSSR, 1956, 106, No 3, 419-421

Abstract : An investigation was made of the galvanomagnetic effect in a nickel wire 20 cm long, 0.05 mm in diameter. During the investigation use was made of a compensator -- a similar nickel wire, wound in the form of a helix, whose turns are perpendicular to the field. The use of a compensator has made it possible to exclude the factor of the dependence of the resistance in the temperature. The temperature was raised from room temperature to the Curie point and again reduced to room temperature. The magnitude of the

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Abs Jour : Ref Zhur - Fizika, No 5, 1957, 11995

galvanomagnetic effect was determined in fields of 12, 39, 110 Oe. It was found that the values of the galvanomagnetic effect, in the general case, during the heating and cooling processes, were different for the same temperatures and fields. This fact indicates that there is a temperature hysteresis in the galvanomagnetic effect.

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PHASE I BOOK EXPLOITATION

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Kirenskiy, Leonid Vasil'yevich.

Ferromagnetizm i yego primeneniye (Ferromagnetism and its Application)  
Moscow, Uchpedgiz, 1957. 102 p. 12,500 copies printed.

Ed.: Dukov, V.M.; Tech. Ed.: Maksayev, A.V.

**PURPOSE:** The purpose of the monograph is not stated, but in view of the fact that it was published by the State Scientific and Pedagogical Publishing House of the Ministry of Education of the Russian SSR, one can assume that it is intended for use as a secondary school manual.

**COVERAGE:** Written in a popular style, the booklet contains a comprehensive account of the phenomenon of ferromagnetism, and of ferromagnetic substances and processes and their practical application. Chapter 2 contains a brief history of investigations on magnetism. The names of two Soviet physicists, Akulov, N.S. and Dekhtyar, M. are mentioned (p. 53 and ff) in connection with "Akulov-Bitter figures" and several basic works on ferromagnetism. There are no references.

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Ferromagnetism and its Application (Cont.)

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\*Translator's Note: The original seems to contain 2 misprints.  
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AVAILABLE: Library of Congress (QC753.K48)

JJP/MTL

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KIRENSKIY, L.V.

AUTHORS: Kirenskiy, L. V., Nosova, R. S.,  
Reshetnikova, N. V.

48-8-9/25

TITLE: Several Temperature Dependent Magnetic  
Properties of Nickel (Temperaturnaya zavisimost'  
nekotorykh magnitnykh svoystv nikelya).

PERIODICAL: Izvestiya AN SSSR Seriya Fizicheskaya, 1957, Vol. 21,  
Nr 8, pp. 1105-1110, (USSR)

ABSTRACT: The paper contains the following investigations:  
a) of the dependence of the energy constant of the  
magnetic anisotropy on the intensity of the magnetic  
field at various temperatures and b) on the  
temperature dependence of the galvanomagnetic effect  
in saturated fields.  
The first case was studied exhaustively by Tarasov. He  
used disks of siliciferous iron as samples and  
arrived as a result from his investigations at the  
following equation in the range of field strengths  
from 2000-3000 Oe :  $M = M_{00} (1 - \frac{A}{H})$ , M denoting the  
maximum value of the mechanical moment acting upon the  
disk in a homogenous magnetic field  $M_{00}$  the moment

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Several Temperature Dependent Magnetic Properties 48-8- 9/25  
of Nickel

acting in the case of an infinitely strong field and  $A$  a constant. It is assumed, that the value of the mechanical moment is proportional to the value  $K$  (anisotropy constant) and takes the value  $K = 2M$  in the plane with an angle of  $22'50''$  between the field direction and the tetragonal axis of the crystal. Therefore in the case of strong fields the equation is obtained:

$K = K_{00} (1 - \frac{A}{H})$  Further research by Williams and

Bozorth as well as by Shubina furnished, that the equation for  $M$  is not always applicable, the second equation for  $k$  however, holds even in the case of very strong fields. Therefore it must be assumed, that the dependence of the anisotropy constant on the intensity of the magnetic field must be determined from the second  $K$ -equation with respect to the  $A$ -value corresponding to the temperature dependence. The author maintains, that no research has been conducted on this field, and therefore this paper was dedicated to it. A Nickel sphere of 9.75 mm diameter was used as a sample, which was

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Several Temperature Dependent Magnetic Properties of Nickel 48-8-9/25

subjected to magnetic fields at temperatures between 20-300°C. From a diagram it is established in the final conclusions of the paper, that the value of  $\lambda$  appears to be independent from temperature in the interval from 20-135°C. A further increase of temperature is connected with a dropping value of  $\lambda$ , which at 170°C even inverts its sign. At the same time it was established, that the maximum values of the mechanical moment do not change after every 45 degrees, but alternatively at 47, 43, 47, 43 degrees and so on, the minimum (zero) values, however, change after every 45 degrees. With respect to the dependence of the galvanomagnetic moment it is established here, that it increases markedly in weak magnetic fields. It decreases at the transition to the process of rotation, dependent on its approximation to the saturation point. In fields above the technical saturation the galvanomagnetic moment diminishes in connection with the paraprocess. With growing temperature the effect is weakened and the saturation occurs in the weak fields.

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Several Temperature Dependent Magnetic Properties      48-8-9/25  
of Nickel

Finally it is stated here, that the absolute value of the effect is largely dependent on the method of de-magnetisation. Therefore it is considered to be suitable to conduct the de-magnetisation at temperatures above the Curie point, and to pursue the cooling, down under a magnetic shield. There are 10 figures, and 10 references, 7 of which are Slavic.

ASSOCIATION: Krasnoyarsk State Pedagogical Inst. (Krasnoyarskiy gos. pedagogicheskiy institut)

AVAILABLE: Library of Congress

CARD 4/4

KIRENSKIY, L.V.

48-8-18/25

AUTHORS: Kirenskiy, L. V., Dylgerov, V. D.,  
Savchenko, M. K.,

TITLE: Dynamics of the Doma Structure in Crystals of Silicious Iron  
(Dinamika domennoy struktury v kristallakh kremnistogo zheleza)

PERIODICAL: Izvestiya AN SSSR, Ser. Fiz., 1957, Vol. 21, Nr 8, pp. 1168-1169  
(USSR)

ABSTRACT: According to recent opinions, the process of technical magnetization consists of two stages: The process of shifting of doma partition walls and the process of the rotation, and is due to stresses occurring in the crystal. The paper deals with the results obtained by the investigation of powder patterns in the case of a constant change of stresses and magnetic fields, as also the observation of the rotation processes according to the powder pattern method. As samples disks of 13 mm diameter and 0,2 thickness and for the investigation of stress stripes 3x5x0,2 mm, which were cut out in different crystallographic directions, were used. In the chapter: Effect of elastic stresses it is said that the original doma structure in the case of the said sample (without the influence of stress) forms nearly parallel and in parts broken lines at unequal distances. The last-mentioned circumstance, that of the broken line, is explained by the effect produced by

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Dynamics of the Doma Structure in Crystals of Silicious Iron. 48-8-18/25

weak internal stresses, as well as also by the non-uniformity of the structure of the sample. If the sample is stretched in a longitudinal direction, stretching of the structure of the doma lines takes place in the transverse direction by the parallel shifting of the doma partitions, on which occasion a corresponding equalization of stresses occurs. In this case also wedge-shaped doma partitions may occur, which broaden in the direction of their point as soon as the extending force is applied. When the samples are extended in the transverse direction, the sharp doma partition walls may be dissolved. The structure on this occasion becomes wedge-like and, in the course of further extension, the unevenly distributed line particles are formed. With a further extension of these line parts they form a peculiar sort of ordered mosaic. In the case of extension in a certain direction it was observed that the doma structure was divided, on which occasion new partition walls were formed or partition walls disappeared entirely. The chapter: The influence of the external magnetic field describes the process of extending the sample in a direction in which its magnetic structure assumes a uniaxial character. In these uniaxial crystals the processes of rotation are then observed and investigated by means of powder patterns. Rotation of the magnetization vector was determined according to saturation figures,

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Dynamics of the Doma Structure in Crystals of Silicious Iron. 48-8-18/25

which were always perpendicular to the direction of the magnetization vector. In this paper series of cinematographic films are mentioned which confirm the aforementioned statement. There are 8 figures and 2 non-Slavic references.

ASSOCIATION: Krasnoyarsk State Pedagogical Institute (Krasnoyarskiy gos. pedagogicheskiy institut)

AVAILABLE: Library of Congress

Card 3/3

KIRENSKIY, L. V.

AUTHORS: Kirenskiy, L. V., Vlasov, A. Ya., Vtyurin, M. I. 48-2-12/26  
Drokin, A. I., Ivlev, V. F., Tkalov, R. I.

TITLE: Note on the Temperature- and Circular-Hysteresis in Ferromagnetic Substances (Temperaturnyy i vrashchatel'nyy gisteresis v ferromagnetikakh).

PERIODICAL: Izvestiya AN SSSR Seriya Fizicheskaya, 1957, Vol. 21, Nr 9, pp. 1262-1267 (USSR.).

ABSTRACT: In this paper experimental investigations were conducted of: 1) The temperature hysteresis of magnetization according to the B-cycle (cooling-heating) (TMH), 2) the temperature hysteresis of magnetostriction (TMH), 3) the temperature hysteresis of the galvanomagnetic effect (THGE) according to the A-cycle (heating-cooling), 4) the phenomenon of the "circular" hysteresis of magnetostriction was established and investigated parallel to the study of the losses in rotating magnetic fields. The investigations were conducted on various samples of nickel. On the examination of the TMH effect thick samples showed a much more marked effect than thin ones. If further cooling is applied, the thicker samples are subject to the effect of the demagnetization factor, which reduces the originally weak field. The importance of the energy of anisotropy grows, because of which fact

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Note on the Temperature- and Circular-Hysteresis in

48-9-12/26

"APPROVED FOR RELEASE: 09/17/2001

CIA-RDP86-00513R000722610016-6"

the magnetization vectors of the domains do not arrange themselves parallel with the magnetic field, but along the easier direction of magnetization, which cannot coincide with the orientation of the weak field. It is shown, that the THM-effect diminishes with the growth of the field. No THM-effect is observed in fields of the order of magnitude of 100 Oe. Analogous observations were made in the case of the THOE-effect. The magnitude of THM and THGE depends on the initial temperature of heating and on the final point of heating (conversion point), if it is below the Curie point. Analysis of the magnetographs from the magnetic recorder showed, that the magnetostriction as well as the UHM-effect grows strongly with an increase of the field from 100 to 1000 Oe and on a further increase of the fields tends asymptotically to its maximum values. There are 11 figures and 8 Slavic references.

ASSOCIATION: State Institute for Pedagogics of Krasnoyarsk (Krasnoyarskiy gos. pedagogicheskiy institut).

AVAILABLE: Library of Congress.

Card 2/2

*KIRENSKIY, L. V.*  
AUTHOR: Kirenskiy, L. V., Doctor of Physico -Mathematical Sciences. 30-10-15/26  
TITLE: The Physics Institute in Krasnoyarsk (Institut fiziki v Krasnoyarske).  
PERIODICAL: Vestnik AN SSSR, 1957, <sup>19.11</sup>October, Nr 10, pp. 104-107 (USSR)  
ABSTRACT: The following problems are in process of elaboration at the Physics Institute of the AS USSR in Krasnoyarsk:  
1) Investigation of all problems related with ferromagnetism:  
a) hysteresis loss in rotating fields.  
b) Investigation on the temperature hysteresis of magnetostriction.  
c) Investigation on the Barkhausen effect on various semi-crystalline materials and on mono-crystals at various temperatures.  
d) Improvement of the methods of magnetic measurements.  
e) Investigation of many new ferromagnetics within the range of saturation.  
2) Research works in the biophysical laboratory:  
a) Elaboration of the spectroscopic analysis of adsorption of biophysical processes.


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The ~~Physics~~ Institute in Krasnoyarsk

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- b) Investigation of changes of biological systems in state of dynamic equilibrium by means of photo-electrical recording of light-absorption or light-diffusion.
  - c) Investigation of the physiological inhomogeneity of corpuscles (erythrocytes) with statistic methods.
  - d) Investigation on the kinetic change of the haemolysis with living animals after having suffered an "irradiation".
- 3) Research works in the spectroscopic laboratory.
- a) Investigation of the crystalline structure of various materials.
  - b) Determination of both intermolecular and internal molecular bonds by investigating the combined dispersing spectra with small frequencies.
  - c) Improvement of the theory and the practical application of the spectroscopic analysis of emission.
  - d) Investigation on micro-elements in the alimentation of animals.

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The Physics Institute in Krasnoyarsk

30-10-15/26

The whole institute is under reconstruction for the time being. Above all the structural alterations are still in process.

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SOV/137-58-9-19767

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 9, p 236 (USSR)

AUTHORS: ~~Kirenskiy, L.V.~~, Savchenko, M.K.

TITLE: Domain Structure of the Crystals of Ferrosilicon Upon the Application of Elastic Stresses (Domennaya struktura kristallov kremnistogo zheleza pri nalozhenii uprugikh napryazheniy)

PERIODICAL: Izv. vyssh. uchebn. zavedeniy, Fizika, 1958, Nr 1, pp 35-38

ABSTRACT: The results of observations are adduced on the domain structure (with the aid of Bitter's figures) of crystals of ferrosilicon when they are stretched along a [110] direction. The results of a similar earlier work (RZhKhim, 1955, Nr 2, abstract 31155) are confirmed and refined; in particular, besides the two domain types I and II, two more, the so-called "drops" and "chains", were discovered. Observations on both the large single crystals and on the fine-crystalline specimens show the influence of the grain boundaries. It is also shown that upon stretching free dispersion fields are present on the boundaries of the crystals as the result of the reorganization of the domain structure. Microphotos are included. R.O.

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1. Iron-silicon crystals--Structural analysis 2. Iron-silicon crystals  
--Stresses

SOV/137-58-9-19768

Translation from: Referativnyy zhurnal, Metallurgiya, 1958, Nr 9, p 236 (USSR)

AUTHORS: Kirenskiy, L.V., Savchenko, M.K.

TITLE: On Prismatic Interlocking Domains in Ferrosilicon Crystals  
(O prizmaticheskikh zamykayushchikh domenakh v kristallakh kremnistogo zheleza)

PERIODICAL: Izv. vyssh. uchebn. zavedeniy. Fizika, 1958, Nr 1, pp 39-41

ABSTRACT: The change in the structure of the domains of the interlocking type in ferrosilicon crystals (4% Si) was investigated by the method of the Bitter figures upon the stretching of the specimens. Some new data were obtained, which agree with the theory of regions of spontaneous magnetization. Interlocking ranges were likewise discovered not only on the borders of the crystals but also within them.

1. Iron-silicon crystals--Structural analysis  
--Theory

R.O.

2. Iron-silicon crystals

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KIRENSKIY, L.V.; SAVCHENKO, M.K.

Effect of pressure on domain structure near inclusions. Izv.  
vys. ucheb. zav.; fiz. no.3:141-143 '58. (MIRA 11:9)

1. Krasnoyarskiy pedinstitut.  
(Metal crystals) (Crystal lattices)

AUTHORS: Kirenskiy, L. V. and Rodichev, G. M. SOV/139-58-4-24/30  
 TITLE: Investigation on Alloys of Nickel with Silicon of the  
 Law of Approach to Saturation (Issledovaniye zakona  
 priblizheniya k nasyshcheniyu na splavakh nikelya s  
 kremniyem)

PERIODICAL: Izvestiya Vysshikh Uchebnykh Zavedeniy, Fizika,  
 1958, Nr 4, pp 144-151 (USSR)

ABSTRACT: The behaviour of polycrystalline ferromagnetics in  
 strong fields has been the subject of numerous  
 experimental and theoretical investigations (Refs 1-15),  
 as a result of which the law of approach to saturation  
 has been formulated thus:

$$\dot{i} = \dot{i}_s \left( 1 - \frac{a}{H} - \frac{b}{H^2} - \frac{c}{H^3} \right) + \dot{i}_p, \quad (1)$$

$$\chi = \frac{A}{H^2} + \frac{B}{H^3} + \frac{C}{H^4} + \chi_p \quad (2)$$

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Investigation on Alloys of Nickel with Silicon of the Law of  
Approach to Saturation

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where  $\dot{I}$  is the magnetisation of the ferromagnetic in  
a magnetic field of the potential  $H$ ;

$\dot{I}_s$  - spontaneous magnetisation;

$\dot{I}_p$  - magnetisation caused by the paraprocess,

$\chi$  - differential susceptibility;

$\chi_p$  - susceptibility of the paraprocess;

$a, b, c$  and  $A, B, C$  - coefficients dependent on the  
magnetic constants of the ferromagnetics  
and also on the internal and external  
stress and the non-magnetic inclusions.

Most of the published work on investigating the law  
of approach to saturation has been carried out on pure  
ferromagnetic materials and the authors of this paper

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Investigation on Alloys of Nickel with Silicon of the Law of  
Approach to Saturation

considered it of interest to investigate this law on alloys, choosing for this purpose alloys of nickel with silicon. The dependence is investigated of the coefficients in the law of approach to saturation on the silicon content and also the dependence of the susceptibility of the paraprocess on the magnetising field. Since alloys of nickel with silicon have a low Curie point, it can be anticipated that in these the paraprocess will be very pronounced and, therefore, it can be investigated in relatively weak fields. According to the theory of Holstein and Primakoff (Ref 7), the dependence on the field of the susceptibility of the paraprocess can be expressed by the relation:

$$\chi_p = p/H^{1/2}$$

This dependence was experimentally detected only by

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Investigation on Alloys of Nickel with Silicon of the Law of Approach to Saturation

Parfenov (Ref 15); other investigators were unable to detect this dependence since in their investigations the range of the applied fields was not large enough. The authors of this paper investigated the dependence on the field of the differential susceptibility  $\chi$  using a test rig which is described by the authors in another paper (Ref 16). 17 to 18 cm long, 1 mm dia. specimens containing 4, 3 and 0.5% Si and also of 0.4 mm dia. containing 2% Si were tested at 22°C. In Fig.1 the dependence of  $\chi H^2$  on H is graphed for non-annealed specimens containing 0.5, 3 and 4% Si. In Fig.2 the same dependence is graphed for equal but annealed specimens. In Fig.3 the dependence is graphed of  $\chi H^{3/2}$  on H for annealed specimens containing 3 and 4% Si. In Fig. 4 the dependence of  $\chi$  on  $H^{-1/2}$  is graphed for annealed specimens containing 4% Si. Other determined relations

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Investigation on Alloys of Nickel with Silicon of the Law of  
Approach to Saturation

are graphed in Figs. 5-8. The following conclusions are arrived at: for the investigated Ni-Si alloys the applicability of the law of approach to saturation is shifted towards the range of weaker fields and this enabled investigation on these alloys of the susceptibility of the para-process. It was found that the susceptibility of the para-process can be expressed by the equation:

$$\chi = p/H^{1/2},$$

p being a constant. The determined dependence of the coefficient p on the Si content enabled determining the value of this coefficient for pure nickel by extrapolation. The thus determined value of the coefficient p is near to its theoretical value calculated by means of the theory of Holstein and Primakoff and, as regards its order of magnitude, it is in agreement with the results obtained by Parfenov (Ref 15). Measurements on specimens containing 4% Si have shown that the expression for the differential susceptibility for such specimens contains a

Card5/6 term r which is independent of the field. The

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Investigation on Alloys of Nickel with Silicon of the Law of  
Approach to Saturation

coefficients A, B and C and also the anisotropy constant  
 $K_1$  decrease with increasing Si content whereby the  
decrease is rapid at first and slows down later.  
There are 8 figures and 18 references, 11 of which are  
Soviet, 6 English, 1 German.

ASSOCIATION: Krasnoyarskiy pedinstitut (Krasnoyarsk Pedagogic  
Institute)

SUBMITTED: February 10, 1958

Card 6/6

DOV/139-58-5-6/35

AUTHORS: Kirenskiy, L. V. and Rodichev, G. M.

TITLE: Investigation of an Approximate (Magnetic) Saturation Law for Small Diameter Nickel Sample (Issledovaniye zakona priblizheniya k nasyscheniyu na nikel'evom obraztse malogo diametra)

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, fizika, 1958, Nr 5, pp 27-34 (USSR)

ABSTRACT: Numerous theories have been proposed to account for the observed fact that the intensity of magnetization in ferromagnetics saturates to a constant value no matter how much the applied magnetizing field is increased beyond the value required to induce this saturation. The saturation formulae have the general form:

$$I = A I_s + \chi H$$

where  $I$  is the intensity of magnetization corresponding to an applied field  $H$ ,  $I_s$  is the intensity of spontaneous magnetization for zero applied field, and  $A$ ,  $\chi$  are coefficients which depend in a somewhat complicated way on  $H$ . The expressions for  $A$ ,  $\chi$  are usually given as series expansions in  $H^{-1}$  and the various theories differ in the values they assign to the coefficients and constant terms in these expansions. Depending on the model assumed, these

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Investigation of an Approximate (Magnetic) Saturation Law for Small  
Diameter Nickel Sample SOV/139-58-5-6/35

quantities are more or less dependent on temperature, crystalline structure, magnetic history and geometrical dimensions of the sample of ferromagnetic under consideration. The present paper reports on an investigation of the saturation properties of a 0.43 mm diameter sample of nickel using fields  $H$  ranging up to approximately  $10^4$  oersteds. A high frequency ferro-resonance circuit was used with the nickel sample forming the core of one of the inductances. The output voltage wave-form was analysed in terms of the circuit constants for various applied fields and in this way a curve of  $I$  against  $H$  was obtained; in particular the circuit constants were adjusted to permit a large number of closely spaced readings to be taken in the region of the saturation field. An approximate analytic representation for the  $I$ - $H$  curve is obtained by taking:

$$A = 1 - \frac{b}{H^2}$$

Card 2/3 in the above formula, with  $b$  (at room temperature) equal to

SOV 159-58-5-6/55

Investigation of an Approximate (Magnetic) Saturation Law for Small Diameter Nickel Sample

$-4I_s^{-2} \times 10^3$ ; and by expanding the susceptibility  $\chi$  as:

$$\chi = \frac{A}{H^2} + \frac{B}{H^3} + \frac{C}{H^4} + \chi_r$$

It is shown that the last two terms on the right can in fact be replaced for practical purposes by a single term  $p/H^4$ . In this simplified formula for  $\chi$  the following (room temperature) values are assigned to the numerical coefficients:

$A = 1.197 \times 10^3$ ;  $B = 6.614 \times 10^5$ ;  $p = 0.01$ .

The paper contains 4 figures and 23 references, 12 of which are Soviet, 5 German, 5 English and 1 French.

ASSOCIATION: Krasnoyarskiy pedinstitut (Krasnoyarsk Teaching Institute)

SUBMITTED: February 10, 1958.

Card 3/3

SOV/139-58-5-10/35

AUTHORS: Kirenskiy, L. V., Vlasov, A. Ya. and Vtyurin, N. I.

TITLE: Magnetostriction Hysteresis in Rotating Magnetic Fields  
(Gisterezis magnitostriktzii v vrashchayushchikhsya magnitnykh  
polyakh)

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, fizika, 1958,  
Nr 5, pp 52-54 (USSR)

ABSTRACT: The paper reports experimental investigation of the rotational magnetostriction hysteresis. Measurements were made on a rolled polycrystalline nickel disc 1.02 mm thick and 14.20 mm dia. The degree of the rolling reduction of the disc was 54.7%. The disc was subjected to a 3-hour annealing in vacuo at 1000°C and subsequent slow cooling in a magnetically screened enclosure. Magnetostrictional changes in dimensions of the sample were measured with a wire probe, glued to the sample in the direction of rolling. Both the rotational magnetostriction hysteresis and the rotational magnetization hysteresis losses were measured. Mechanical moments acting on the sample placed in a magnetic field were measured by means of a torque magnetometer whose sensitivity

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SOV 152-28-5-10/35

## Magnetostriction Hysteresis in Rotating Magnetic Fields

was 4 oersted/mm. The magnetic field was produced by means of an electromagnet which rotated with respect to the sample from 0 to 360° both in forward and reverse directions. The changes in mechanical moments in magnetostriction were recorded on a photographic film in a cylindrical camera which could rotate together with the electromagnet. Special attention was paid to a removal of the possible effect of free-play between the coupled motions of the electromagnet and the recording camera. Measurements were made at 20°C in fields from 100 - 4850 oersted. Fig.1 shows a recording of the curves representing the change in mechanical moments (A), and magnetostriction (B) of nickel both in forward and reverse rotation of a 4850 oersted magnetic field. The magnetization hysteresis losses were calculated from the areas between the curves representing moments. The results (Fig.2) show that the magnetization hysteresis losses increase with increase of the external magnetic field up to 1500 oersted. Between 1500 and 3000 oersted the losses decrease with increase of the magnetic field and above 3000 oersted they start increasing again. Magnetograms shown in Fig.1 indicate that in addition to the rotational magnetization hysteresis there is also a rotational magnetostriction hysteresis (curves B). Both the

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SOV/139-58-5-10/35

Magnetostriction Hysteresis in Rotating Magnetic Fields

magnetostriction itself (curve 1 in Fig.3) and the maximum rotational magnetostriction hysteresis (curve 2 in Fig.3) increase rapidly with the magnetic field strength for fields from 0 to 1000 oersted. Above 1000 oersted both curves of Fig.3 approach saturation values. There are 3 figures and 6 Soviet references.

ASSOCIATION: Institut fiziki Sib.otdeleniya AN SSSR, Krasnoyarskiy pedagogicheskiy institut (Physics Institute, Siberian Division of the Academy of Sciences, USSR; Krasnoyarsk Pedagogical Institute)

SUBMITTED: March 20, 1958.

Card 3/3

AUTHOR: Kuznetsov, V.Ye.

SOV-26-58-11/9/49

TITLE: Investigations of the Magnetic Structure of Ferromagnetics (Issledovaniya magnitnoy struktury ferromagnetikov). An All-Union Conference in Krasnoyarsk (Vsesoyuznoye soveshchaniye v Krasnoyarske).

PERIODICAL: Priroda, 1958, Nr 11, pp 53-55 (USSR)

ABSTRACT: In June 1958 an All-Union meeting on the magnetic structure of ferromagnetics was convoked by the Institut fiziki AN SSSR (Institute of Physics of the AS USSR) and the Komissiya po magnetizmu Otdeleniya fiziko-matematicheskikh nauk AN SSSR (Commission for Magnetism of the Department of Physico-Mathematical Sciences of AS USSR) in Krasnoyarsk. The meeting was attended by representatives of scientific institutions of many principal cities of the USSR. A total of 32 papers were read. Ya.S. Shur of the Institut fiziki metallov AN SSSR (Institute of the Physics of Metals, AS USSR) in Sverdlovsk summarized the magnetic structure of ferromagnetics. G.V. Spivak of the Moskovskiy gosudarstvennyy universitet (Moscow State University) told of present and future electron-optical methods of study of the domain structure of ferromagnetics. L.V. Kirenskiy and M.K. Savchenko of the Institute of Physics of the AS USSR in Krasnoyarsk presented new data on the spatial distribution of the domain structure in samples of transformer iron. A.I.

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SOV-26-59-11-9/49

Investigations of the Magnetic Structure of Ferromagnetics

Sudovtsev and Ye.Ye. Semenenko of the Fiziko-technicheskiy institut AN USSR (Physico-Technical Institute of AS UkrSSR) in Khar'kov read a paper on the influence of the domain structure on the electrical conductivity of very pure iron. G.V. Spivak, V.Ye. Yurasova and Ye.I. Shishkina of Moscow University presented an original method of exposure of magnetic heterogeneity in metal. T.I. Prasova of the Verkh-Isetskiy metallurgicheskiy zavod (Verkh-Isetskiy Metallurgical Plant) told of experimental work carried out in cooperation with V.V. Druzhinin on the application of the method of powder patterns to the study of the magnetic properties of transformer steel. G.P. D'yakov of Moscow University spoke on the calculation of the domain structure in the theory of magnetization and magnetostriction of monocrystals. L.V. Kirpinskiy and I.P. Degtyarev of Krasnoyarsk read a paper on the temperature dependence of the domain structure of crystals of ferrosilicon. V.A. Zaykova and Ya.S. Shur reported on the results of a study of the influence of elastic stresses on the magnetic structure of the crystals of ferrosilicon. V.V. Veter of the Institute of Physics of the AS USSR in Krasnoyarsk reported on his original work conducted together

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SOV-26-58-11-9/49

Investigations of the Magnetic Structure of Ferromagnetics

with L.V. Kirenskiy on the determination of the width of the domain boundary; the method had been suggested by G.S. Krinchik. I.M. Puzey, of the Tsentral'nyy nauchno-issledovatel'skiy institut chernoy metallurgii, Moskva (Central Scientific Research Institute of Iron Metallurgy, Moscow) communicated the results of studies of the dynamics of the domain structure in a frequency range of up to several mhz. A.I. Drokin, D.A. Laptey, and R.P. Smolin (Krasnoyarsk) presented results of their studies of the temperature magnetic hysteresis on the points of the hysteresis loop. Nickel and iron-nickel alloy samples had been studied for this purpose. I.Ye. Startseva and Ya.S. Shur read a study of the structure of the residual magnetized ferromagnetic by aid of the method of powder patterns, and the change of this structure under the influence of a changing magnetic field. The papers of L.V. Kirenskiy, A.I. Drokin and V.S. Cherkashin dealt with the results of the influence of ultrasonic waves on the magnetic properties of ferromagnetics at various temperatures. Several papers were devoted to further investigations of the

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SOV-26-58-11-9/49

Investigations of the Magnetic Structure of Ferromagnetics

Barkhausen effect, the concept of which has been considerably extended by such Soviet researchers as R.V. Telesnin, Ye.P. Dzaganiya, V.F. Ivlev and others. Several papers dealt with transitional magnetic structure and temperature changes. The Physical Institute of the AS USSR in Krasnoyarsk, in 1957 opened the Stolby Game Reservation. The construction site of the Krasnoyarsk Hydroelectric Power Station was visited by the scientists.

1. Magnetostriction--Properties

Card 4/4

AUTHORS: ~~Kirenskiy, L. V.~~, Savchenko, M. K., SOV/48-22-10-4/23  
Rodichev, A. M.

TITLE: Dynamics of Domain Structure in Crystals of Transformer Sheet Iron Under the Influence of Tensions (Dinamika domennoy struktury v kristallakh transformatornoy stali pod deystviyem napryazheniy)

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, 1958, Vol 22, Nr 10, pp 1181 - 1184 (USSR)

ABSTRACT: By means of the powder patterns by Akulov, Dekhtyar, and Bitter (Ref 1) in the present paper the effect of elastic strain on the domain structure of the crystals of cold-rolled transformer sheet iron (3,4% Si) was investigated. It was shown that the domain structure changes considerably when a strain is applied. The character of these changes depends on the orientation of the stress. On the crystal surface that coincides with the plane (110) the powder pattern has the form of parallel lines. These lines have the direction of the axis of the weak magnetization which is next to the surface. This speaks for the fact that the domain structure consists of plane-parallel layer domains.

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Dynamics of Domain Structure in Crystals of  
Transformer Sheet Iron Under the Influence of  
Tensions

SOV/48-22-10-4/23

These layer domains are oriented in the direction of the powder lines and are magnetized in the same direction. The plane-parallel layer domains never exhibit the same width in one and the same sample. The application of the stress to the sample compensates for the whole tension in the sample and thus also for the domain structure. During strain application sometimes a separation of the layer domains into two halves can be observed. This separation comes as a consequence of new boundaries, (Fig 1). It must be mentioned that the remagnetization of a number of domains is not caused by the dislocation of the boundary but apparently by a sudden inversion of whole domains. Tensions that are directed along the axis (110) in the crystal completely rebuild the original structure of the domains. If the stress is sufficiently high two new types of figures appear (Fig 2). For reasons of comparison also finely crystalline samples with a linear grain dimension of 1 - 1,5 mm were observed. A more or less simple law connecting the width and the magnitude of the stress could not be found.

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Dynamics of Domain Structure in Crystals of  
Transformer Sheet Iron Under the Influence of  
Tensions

SOV/48-22-10-4/23

As was observed, the domain structure changes when the stress is oriented along the direction of the complex magnetization as well as when it is directed along the axis of the weak magnetization. In crystals the surface of which coincides with the plane (100) a change of the domain structure of the closed type was observed when a strain was applied. Reproductions of powder patterns show that the layered structure of the ferromagnetic domains must exhibit closed domains for excluding the formation of free stray-fields. The powder pattern method alone is not perfect and may be applied more successfully if it is combined with another method. In the present paper apart from observations of powder patterns also the Barkhausen (Barkgauzen) jumps were recorded. Figure 4 shows the results. There are 4 figures and 2 references, 1 of which is Soviet.

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7(4), 24(3)

SOV/30-58-11 39/48

AUTHOR: Kirenskiy, L. V., Doctor of Physical-Mathematical Sciences

TITLE: Magnetic Structure of Ferromagnetics (Magnitnaya struktura ferromagnetikov) All-Union Conference in Krasnoyarsk (Vsesoyuznoye soveshchaniye v Krasnoyarske)

PERIODICAL: Vestnik Akademii nauk SSSR, 1958, <sup>14</sup>Nr 11, pp 122-124 (USSR)

ABSTRACT: In accordance with the plan of the Nauchnyy sovet po problemam magnetizma Akademii nauk SSSR (Scientific Council for Problems of Magnetism of the AS USSR) the Institut fiziki Sibirskogo otdeleniya Akademii nauk SSSR (Institute of Physics of the Siberian Branch of the AS USSR) held this conference from June 10 to 15. About 100 scientists from more than 20 scientific institutions and universities took part in this conference. More than 30 reports were given and discussed, dealing with the study of the blast-furnace structure of ferromagnetics, of the Barkhausen effect and various irreversible processes in ferromagnetics. Moreover, reports were given by: Ya. S. Shur on the Discovery of the Elastic Magnetic Hysteresis of Blast-Furnace Structure, V. V. Druzhinin, T. I. Prasova on the Dependence of the Technical Properties of Magnetic Steels on

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Magnetic Structure of Ferromagnetics. All Union Conference in Krasnoyarsk SOV/30-58-11 39/40

Their Blast-Furnace Structure. G. V. Spivak and his collaborators on very promising electronic-optical methods of investigating the blast-furnace structure of ferromagnetics. R. V. Telesnin, Ye. P. Dzaganiya on research conducted concerning the retarded jumps in magnetization depending on the conditions of heat treatment, elastic tensions, nature of change in the magnetic field and other factors. I. M. Puzey on results of research concerning the dynamics of blast-furnace structure in a frequency range up to a few megacycles. A. I. Sudovtsev, Ye. Ye. Semenenko on the question of the influence of blast-furnace structure on the electric conductivity of very pure iron at low temperatures. G. S. Krinchik on the structure of the blast-furnace boundary (domennaya granitsa) and the dynamic properties of ferromagnetics. G. P. D'yakov on the place held by blast-furnace structure in the theory of magnetization and magnetostriction of mono-crystals. The participants in the conference visited the laboratories of the Institut fiziki (Institute of Physics), the National Park of "Stolby" and the Krasnoyarskaya GES under construction.

Card 2/2

24(6), 24(3)

AUTHORS:

Kirenskiy, L. V., Degtyarev, I. F.

SOV/56-35-3-4/6

TITLE:

On the Temperature Stability of the Domain Structure  
in Iron Silicate Crystals (O temperaturnoy ustoychivosti  
domennoy struktury v kristallakh kremniyogo zheleza)

PERIODICAL:

Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958,  
Vol 35, Nr 3, pp 584 - 586 (USSR)

ABSTRACT:

In the present paper the authors speak about the investigations of 3% iron silicate within the range of temperature of 20-700°C by means of the meridian magnetooptical nuclear effect. Figure 1 is a schematical representation of the arrangement used for the illustration of the domain structure by means of the meridian effect. Figure 2 shows a scheme of the entire experimental device. An iron silicate monocrystal shaped in form of a small plate having the measurements 25.4.0,3 mm<sup>3</sup> in the (110) plane was investigated. The sample was tempered under a pressure of 10<sup>-3</sup> torr at a temperature of about 1000°C for three hours. The

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On the Temperature Stability of the Domain Structure in ~~SiO<sub>2</sub>/Si<sub>3</sub>N<sub>4</sub>-Si<sub>3</sub>N<sub>4</sub>/SiO<sub>2</sub>~~  
Iron Silicate Crystals

Inertialess experimental arrangement made it possible to carry out correct investigations also in the case of rapid variations of the magnetic field and the elastic tensions, particularly because the optical arrangement was such that both photographic- and cinematographic pictures could be taken. Figure 1 shows the photoreproductions of various domain structures observed (normal, without magnetic field) at 20, 100, 200, 300, 400, 500, 600 and 700°C. Figure 3 shows the variation of the domain structure in the presence of a field, viz. for  $H=0$ ,  $H=15$  Oe  $H=25$  Oe and  $H=60$  Oe. The results obtained show that for the (110) plane the domain structure is very stable within the temperature interval investigated. There are 4 figures and 7 references, 3 of which are Soviet.

ASSOCIATION: Institut fiziki Sibirskogo otdeleniya Akademii nauk SSSR  
(Physics Institute of the Siberian Department of the  
Academy of Sciences USSR)

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24(3)

AUTHORS: Kirenskiy, L. V., Veter, V. V.

SOV/56-35-3-55/61

TITLE: The Variation of the Breadth of the Boundary Layer in Ferromagnetics by Means of the Magneto-Optical Kerr-Effect  
(Izmeneniye shiriny granichnogo sloya v ferromagnetikakh s pomoshch'yu magnetoopticheskogo effekta Kerra)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 35, Nr 3, pp 819-819 (USSR)

ABSTRACT: In the present paper the method developed by Krinchik (Ref 2) is, in principle, employed, which is based upon the application of the polar magneto-optical Kerr-effect. This permits direct measurement of the breadth of the boundary layer. It is possible to show that for the mean value of the normal component of the magnetization of the boundary layer the expression  $2J_s/\pi$  applies, where  $J_s$  denotes the saturation-magnetization of the ferromagnetic domain. The variation of the light current on a boundary layer as a result of the rotation of the polarization plane and the variation of the light current in the investigated part of the ferromagnetic domain were measured by means of the photoelectronic multi-

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The Variation of the Breadth of the Boundary Layer in Ferromagnetics by  
Means of the Magneto-Optical Kerr-Effect

SOV/56-35-3-55/61

plier FEU. —18. The direct proportionality between the quantities leads to the relation  $\Delta\Phi/\Delta\Phi' = ld/S'$ . Here  $\Delta\Phi$  denotes the variation of the light flux emanating from the boundary layer,  $\Delta\Phi'$  - the variation of the light flux emanating from the investigated part of the sample (which was normally magnetized up to the value of  $2J_s/\pi$ ,  $l$  - the length of the boundary layer,  $d$  - the breadth of the boundary layer,  $S'$  - the area of the investigated part of the sample. Thus,  $d$  is determined by comparison of the light fluxes and surface areas. The breadth of the boundary layer was determined for monocystals of iron silicide (3 % Si). Repeated measurements resulted in the value  $0,8 \mu$  for this breadth. There are 4 references, 3 of which are Soviet.

ASSOCIATION: Sibirskoye otdeleniye Akademii nauk SSSR (Siberian Department of the Academy of Sciences, USSR); Institut fiziki (Institute of Physics)

SUBMITTED: July 11, 1958  
Card 2/3

FRANK I. BOKK EXPOSITIVE 807/342  
Voprosy fizicheskoy khimii i teorii i prikladnoy pedagogicheskoy  
literatury.

Prilozheniya k izdaniyu voprosov i teorii i prikladnoy pedagogicheskoy  
literatury. 9 (Application of Ultrasonics in the Study of the Properties of  
Matter, 1959, No. 9). Errata ally inserted. 1,000 copies printed.

Moscow, V. P. Moskva, Professor, and R. B. Eshparyan, Professor.

NOTE: This collection of articles is intended for scientists specializing in  
ultrasonics, and for those interested in the application of ultrasonics to  
the study of the properties of materials, and to the quality control of such  
parts and structural elements.

CONTENTS: The collection contains the transactions of the All-Union Con-  
ference of Professors and Teachers of Pedagogical Institutes. The articles  
report on research, theoretical and experimental investigations in the field  
of ultrasonics and discuss the application of ultrasonics to the study of

Cont. 3/7

# Application of Ultrasonics (Cont.)

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# Application of Ultrasonics (Cont.)

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KIREVSKIY, L. V.

KIRENSKIY, L.V.; DROKIN, A.I.; LAPTEV, D.A.

Effect of compression on the magnetic hysteresis of nickel  
under fluctuating temperature. Izv.Sib.otd.AN SSSR no.2:9-14  
'59. (MIRA 12:7)

1. Institut fiziki Sibirskogo otdeleniya AN SSSR.  
(Hysteresis) (Nickel)

24.7000

1979  
SOV/10-1-13/36

AUTHORS: Kirenskiy, L. V., Savchenko, N. E.  
 TITLE: Domain Forms in Ferromagnetic Crystals  
 PERIODICAL: Kristallografiya, 1979, Vol. 4, No. 1, pp. 702-709  
 (USSR)  
 ABSTRACT: Having cited some interpretation possibilities on the basis of existing theoretical models, the authors note that the forms and dispositions of ferromagnetic domains in real crystals are more complicated than in theoretical models, but no means are available to observe them in the interior parts of crystals directly. They observed domain boundaries simultaneously on the opposite sides of specimens by a set of two metallographic microscopes see (Fig. 1), in order to see whether or not the domain walls completely penetrate the specimens. The sheets of a transformer steel, 30-40 mm long, 6 mm wide and max 0.4 mm thick, were electropolished and vacuum annealed at 1,000° to

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# Domain Forms in Ferromagnetic Crystals

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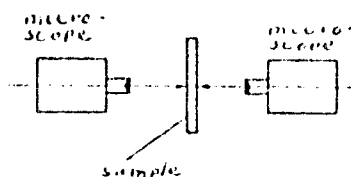


Fig. 1.

1,100° C for 3 hr. Then, the crystals with (110) planes parallel to the sheet surface were cut along  $\angle 001 \angle$ . The domain boundaries on the opposite sides of crystals, especially of those whose (100) planes coincided with the sheet surface, proved to have entirely different patterns. Obviously, the domains, exposed at one surface, do not extend to the opposite surface, but end somewhere within the sheet. Electropolishing the

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Domain Forms in Ferromagnetic Crystals

1000  
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sheets and observing the domain boundaries from time to time, one observed that the sheet thicknesses were gradually reduced to a critical value of 0.02 mm, at which the domain boundaries on the opposite surfaces became identical. The experiment on the domain termini on the surface of sheets of intermediate thicknesses, 0.5 to 0.2 mm, indicated that the domains are not always platy, but may have the form of wedges, triangles, etc. Except for a few cases, the experiments confirmed the theory suggested by G. D. Graham and P. W. Hewarth, that the domain walls in the crystals, oriented with (110) parallel to the sheet surface, are inclined under  $32^\circ$  to the surface normal, i. e. are oblique to the magnetization axis running under  $45^\circ$  to the sheet surface, and that tension stresses parallel to the sheet surface turn the domain walls closer to the surface normal or even parallel to it. This turn could be determined according to the change of the displacement of a domain boundary relative to its position on the other surface at various tension stresses. If domains penetrate the sheet, a uniform

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Domain Forms in Ferromagnetic Crystals

1957

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magnetization can be accomplished at weak magnetic fields. If domains end within the sheet, the magnetization is more rapid in the regions of larger domains. There are 5 figures; and 2 references, 1 Soviet, 1 U. S., 1 French. The U. S. reference is: C. D. Graham and J. E. Neuman, J. Appl. Phys., 8, 881 (1957).

ASSOCIATION: Krasnoyarsk Institute of Physics of the Siberian Branch of the Academy of Sciences of the USSR (Krasnoyarskiy institut fiziki Sibirskogo otdeleniya, AN SSSR)

SUBMITTED: March 31, 1959

Card 4/4

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8/112/60/000/018/003/005  
A005/A001

Translation from: Referativnyy zhurnal, Elektrotekhnika, 1960. No. 13, p. 30,  
# 5.9839

AUTHORS: Kirenskiy, L.V., Drokin, A.I., Cherkashin, V.S.

TITLE: On the Effect of Ultrasound on the Magnetic Properties of Ferro-  
magnetics *yy*

PERIODICAL: V sb.: Primeneniye ul'traakust. k issled. veshchestva, No. 9,  
Moscow, 1959, pp. 131-137

TEXT: Results are presented from an investigation of the ultrasound effect  
on the hysteresis loop of a nickel specimen in weak magnetic fields and at various  
temperatures. The measurement of the intensity of magnetization of the specimen  
was carried out on the vertical astatic magnetometer. A considerable increase in  
the intensity of magnetization was detected owing to the sonic irradiation of the  
specimen; the growth decreased with increasing temperature (vanishing at about

✓

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85755

S/112/60/000/018/003/005  
A005/A001

On the Effect of Ultrasound on the Magnetic Properties of Ferromagnetics

300°C) and was retained after finishing the sonic irradiation process. The magnetic permeability of the specimen increased, too. The results obtained are expounded. - There are 12 references. ✓

ASSOCIATION: Krasnoyarsk. ped. int., in-t fiziki AN SSSR (Krasnoyarsk Pedagogic Institute, Institute of Physics of the Academy of Sciences USSR) III

M.G.S.

Translator's note: This is the full translation of the original Russian abstract.

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24(3)

AUTHORS:

SOV/56-37-3-5/62  
Kirenskiy, L. V., Savchenko, M. K., Degtyarev, I. F.

TITLE:

On Magnetization Processes in Ferromagnetic Substances

PERIODICAL:

Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959,  
Vol 37, Nr 3(9), pp 616 - 619 (USSR)

ABSTRACT:

It was the aim of the present paper experimentally to investigate the dynamics of the domain structure during magnetization; the authors worked with silicon iron crystals with a silicon content of 3%; the samples had the shape of plates ( $30 \times 6 \text{ mm}^2$ ) or disks (20 mm diameter), the thickness of the samples was 0.3 mm or less. The surface of the samples coincided exactly or nearly with the (110) plane, the longitudinal side of the plates with the [001]-direction. The samples were vacuum-tempered at  $1000^\circ\text{C}$  for 2-3 hours, after which they were slowly cooled down in the furnace and electropolished. The change of the domain structure in the magnetic field in the case of growing H was investigated by the method of powder figures and by the method of the meridional magnetic-optic Kerr effect. For visual and photographic observation the samples were covered with a uniform iron oxide layer; by means of the

Card 1/3

1 (3)  
AUTHORS:

Kirenskiy, L. V., Veter, V. V.

TITLE:

The Measurement of the Width of the Boundary Layer Between  
the Domains in Ferromagnetics (Izmereniye shiriny granichnoy  
sloya mezhdu domenami v ferromagnetikakh)

PERIODICAL:

Doklady Akademii nauk SSSR, 1959, Vol. 125, No. 1, pp. 521-524  
(USSR)

ABSTRACT:

The present paper deals with the determination of the width  
of the boundary layer (by means of the magneto-optical  
Kerr effect) of 180-degree proximities in monocrystals of  
ferrosilicon of 3% Si. First, the theory underlying such  
measurements is discussed in short. The authors then describe  
the instruments used for these measurements: 1) The  
microscope MBI-6 with "polaroids" and a special expandable  
slit which is placed in the plane of the field diaphragm.  
2) The photoelectronic multiplier FEU-12 (shielded in a  
special manner from the external magnetic field), which  
consists of a condenser of known capacity, of a resistor  
and of a compensating system. 3) The pulse-spectroscope SI-1  
which is the main measuring part of the instrument. The optical  
scheme of the instrument is shown in a figure. Another

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The Measurement of the Width of the Boundary  
Layer Between the Domains in Ferromagnetics

SCN/20-125-1-16/51

figure shows the integral-balance scheme of the system. The next paragraph of the paper deals with the carrying out of the experiment, that is, with the measurement of  $\Delta\Phi$  and  $\Delta\Phi'$ .  $\Delta\Phi$  denotes the variation of the light flux in the reflection from the boundary layer, and  $\Delta\Phi'$  the variation of the light flux coming from the part of the sample which is magnetized perpendicularly to its surface. The results of these measurements permit the following conclusion: The width of the boundary layer for 180-degree proximities in monocrystals of ferrosilicon is not a stable quantity. As to the first sample (in which the boundaries between the domains run through the whole monocrystal), the boundary layer has a breadth of  $0.49\mu$ . In the same sample, a polarity of boundaries could be observed. The breadth of the boundary layer of the second sample (in which the domain structure had not a regular shape of the layers) amounted to  $0.64\mu$ . There are 3 figures and 7 references, 4 of which are Soviet.

Carl 2/3

101/21-105-1-10, 00  
The Measurement of the Width of the Boundary  
Layer Between the Domains in Ferromagnetics

ASSOCIATION: Institut fiziki Akademii nauk SSSR, Krasnoyarsk  
(Institute of Physics of the Academy of Sciences USSR,  
Krasnoyarsk)

PRESENTED: December 29, 1958, by A. V. Shuknikov, Candidate

SUBMITTED: July 21, 1958

Car: 3/5

24(3)

AUTHORS:

SOV/20-128-2-18/59  
Kirenskiy, L. V., Savchenko, M. K., Degtyarev, I. F.

TITLE:

On Industrial Magnetization of Ferromagnetics

PERIODICAL:

Doklady Akademii nauk SSSR, 1959, Vol 128, Nr 2, pp 288-290  
(USSR)

ABSTRACT:

According to modern concepts, industrial magnetization consists in a shift of the boundaries between the domains and rotation. Investigations of the variation in the domain structure, however, showed that the process of magnetization usually cannot be described only by translation and rotation. Besides these two processes, an additional process was frequently found which may be reduced to the re-formation of the domain structure. Rotation completes industrial magnetization, and the boundaries are shifted before re-formation of the domain structure. In this article the authors report on the above re-formation. Experiments were made by means of iron crystals with a silicon content of 3%. The samples had a diameter of 20 mm and a thickness of 0.3 mm and less. The surface of the samples agreed with the crystallographical plane (110). They were annealed in vacuum for two or three hours, then slowly cooled

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On Industrial Magnetization of Ferromagnetics

SOV/20-128-2-18/59

and electrically polished. The variations in the domain structure within a magnetic field of rising strength were investigated with the help of the powder pattern and the magneto-optical Kerr effect. 24 figures illustrate the structure of domains determined by the magneto-optical method on magnetization in various directions of the sample plane. In the absence of a field, the original pattern is composed of parallel light and dark stripes. The latter correspond to the domains which are magnetized along and opposite to the horizontal light axis [001]. On magnetization the domain structure varies differently in the individual directions. On magnetization along the light axis only a shift of the boundaries by  $180^\circ$  is observable. If just the same sample is magnetized toward the light axis at an angle of  $55^\circ$ , primarily a widening of the light stripes is visible at field strengths of up to 100 oersteds, i.e. a shift of the boundaries. At field strengths of from 100 to 200 oersteds, the domain structure is re-formed. Visual observation clearly indicates that this is an abrupt variation. Further increase to 300 oersteds shifts the boundaries between the domains of the new structure. A variation in the domain structure on magnetization at an angle of  $90^\circ$  toward the light axis is still

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On Industrial Magnetization of Ferromagnetics

SOV/20-128-2-18/59

more complicated, i.e. in the direction [110]. In this case, practically no shift is recorded. At field strengths of up to 90 oersteds, the domain structure practically does not vary. At further increase in the field strength (e.g. from 90 to 200 oersteds), the structure changes to produce a new kind of domain in the form of intermittent stripes. Still further increase of field strength results in a subdivision of the domains, and the pattern assumes the shape of curved stripes in the main direction along the axis [110]. At decreasing field strength, the process develops in the other way round. Magnetization by re-formation of the domain structure proceeds the more strongly the nearer the angle to  $90^\circ$  between the directions of the light axis and the magnetizing field. There are 2 figures and 4 Soviet references.

ASSOCIATION: Institut fiziki Sibirskogo otdeleniya Akademii nauk SSSR  
(Physics Institute of the Siberian Branch of the Academy of Sciences, USSR)

PRESENTED: May 22, 1959, by A. V. Shubnikov, Academician

SUBMITTED: May 14, 1959

Card 3/3

KIRENSKIY, L.V.

PHASE I BOOK EXPLOITATION

SOV/5526

Vsesoyuznoye soveshchaniye po magnitnoy strukture ferromagnetikov,  
Krasnoyarsk, 1958.

Magnitnaya struktura ferromagnetikov; materialy Vsesoyuznogo  
soveshchaniya, 10 - 16 iyunya 1958 g., Krasnoyarsk (Magnetic  
Structure of Ferromagnetic Substances; Materials of the All-Union  
Conference on the Magnetic Structure of Ferromagnetic Substances,  
Held in Krasnoyarsk 10 - 16 June, 1958) Novosibirsk, Izd-vo  
Sibirskogo otd. AN SSSR, 1960. 249 p. Errata slip inserted.  
1,500 copies printed.

Sponsoring Agency: Akademiya nauk SSSR. Institut fiziki Sibirskogo  
otdeleniya. Komissiya po magnetizmu pri Institute fiziki metallov  
OFMN.

Resp. Ed.: L. V. Kirenskiy, Doctor of Physical and Mathematical  
Sciences; Ed.: R. L. Dudnik; Tech. Ed.: A. F. Mazurova.

PURPOSE: This collection of articles is intended for researchers in  
ferromagnetism and for metal scientists.

Card 1/11

SOV/5526

# Magnetic Structure (Cont.)

COVERAGE: The collection contains 38 scientific articles presented at the All-Union Conference on the Magnetic Structure of Ferromagnetic Substances, held in Krasnoyarsk in June 1958. The material contains data on the magnetic structure of ferromagnetic materials and on the dynamics of the structure in relation to magnetic field changes, elastic stresses, and temperature. According to the Foreword the study of ferromagnetic materials had a successful beginning in the Soviet Union in the 1930's, was subsequently discontinued for many years, and was resumed in the 1950's. No personalities are mentioned. References accompany individual articles.

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SOV/5526

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Magnetic Structure (Cont.)

SOV/5526

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Card 10/11

S/196/61/000/010/002/037  
E194/E155

AUTHORS: Kirenskiy, L.V., and Savchenko, M.K.

TITLE: The spatial distribution of domain structures in ferro-magnetics

PERIODICAL: Referativnyy zhurnal, Elektrotehnika i energetika, no.10, 1961, 2, abstract 10B 5. (Symposium "The magnetic structure of ferromagnetics", Novosibirsk, Siberian Division AS USSR, 1960, 25-28)

TEXT: In real ferromagnetics the crystals of the domain structure do not form plane-parallel layers throughout the entire thickness of the crystal. In laminar crystals whose main surface coincides with the plane (110), the domain structure consists of parallel layers directed along the axis (001) but they do not penetrate throughout the crystal thickness. On the opposite side of the laminae the powder figures are usually different. In laminar crystals whose main surface coincides with the plane (100), the domain structure consists of layers directed along one of the axes of magnetisation. This layer does not usually

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The spatial distribution of domain.. S/196/61/000/010/002/037  
E194/E155

penetrate through the thickness of the crystal and layers on opposite sides of the crystal may be perpendicular to one another. As the crystal thickness is reduced its structure alters. At a thickness of about 80 microns the domain structure layer penetrates the entire thickness of the crystal and the boundary layers are normal to the crystal surface from one surface to the other.

5 literature references.

ASSOCIATION: In-t fiziki Sibirskogo otdeleniya AN SSSR,  
Krasnoyarsk  
(Physics Institute of the Siberian Department,  
AS USSR, Krasnoyarsk)

[Abstractor's note: Complete translation.]

Card 2/2

32228

24 2300 1144, 1147, 1148.

S/196/61/000/011/007/042  
E194/E155

AUTHORS: Kirenskiy, L.V., Sudakov, N.I., and Slobodskoy, L.I.

TITLE: Hysteresis loss as a function of temperature in  
rotating magnetic fields in crystals of silicon iron

PERIODICAL: Referativnyy zhurnal, Elektrotehnika i energetika,  
no.11, 1961, 2, abstract 11B 8. (Symposium "Magnetic  
structure of ferromagnetics", Novosibirsk, Sib. otd.  
AN SSSR, 1960, 61-71)

TEXT: Measurements with an improved Akulov anisometer  
showed that in the temperature range - 195 to + 400 °C the change  
in the shape of curves of magnetic moment with increase of field  
takes the same course as at room temperature. With increase of  
temperature the values of the moments decrease, maximum losses of  
rotational hysteresis being displaced towards stronger fields,  
from 550 oersted at - 195 °C to 1200 oersted at 500 °C.  
7 literature references.

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32228

Hysteresis loss as a function of ...

S/196/61/000/011/007/042  
E194/E155

ASSOCIATION: In-t fiziki SO AN SSSR; Pedagogich. in-t.  
Krasnoyarsk  
(Physics Institute SO AS USSR; Pedagogical  
Institute Krasnoyarsk)

X

[Abstractor's note: Complete translation.]

Card 2/2

24.2200

33683

S/058/51/000 012/053/053  
A058/A101

AUTHORS: Kirenskiy, L.V., Drokin, A.I., Cherkashin, V.S.  
TITLE: Effect of ultrasonic waves on the magnetic properties of ferromagnetics at different temperatures  
PERIODICAL: Referativnyy zhurnal. Fizika, no. 12, 1961, 380, abstract 12E558 (V sb. "Magnitn. struktura ferromagnetikov", Novosibirsk, Sib. otd. AN SSSR, 1960, 163 - 173)

TEXT: The effect of ultrasonic irradiation on the magnetization and hysteresis loops of Ni, Permalloy and siliceous Fe in the range from  $-183^{\circ}$  to  $+540^{\circ}\text{C}$  was investigated. It turned out that the lower the temperature at which the experiment was carried out, the greater was the increase in magnetization brought about by ultrasonic irradiation of specimens. For Ni and Permalloy at  $65^{\circ}\text{C}$  the dependence of  $\log \Delta I/I$  (where  $I$  is the magnetization) is linear. The results obtained along different crystallographic directions in a siliceous Fe single crystal are more complicated, but the variation of the  $\Delta I/I=f(i)$  curve is close to exponential.

L. Boyarskiy

[Abstracter's note: Complete translation]

Card 1/1

S/058/61/000/012,063/083  
A058/A101

AUTHORS: Kirenskiy, L.V., Drokin, A.I., Laptey, D.A.

TITLE: Effect of elastic and plastic deformations on the value of temperature magnetic hysteresis

PERIODICAL: Referativnyy zhurnal. Fizika, no. 12, 1961, 385, abstract 12E699 (Vsb. "Magnitn. struktura ferromagnetikov", Novosibirsk, Sib. otd. AN SSSR, 1960, 201 - 209)

TEXT: The variation of temperature magnetic hysteresis was investigated in electrolytic cold-drawn Ni and 65-Permalloy subjected to compression and elongation respectively. It was established that, regardless of the sign of magnetostriction, one-way mechanical stresses that do not exceed the yield point always lead to a decrease of temperature magnetic hysteresis. This decrease is explained by a reduction in the rôle of boundary shifts between domains, as well as by a decrease of the boundary-energy gradient. Above the yield point sharp inhomogeneities arise in the specimen, and this leads to an increase of the boundary-energy gradient and a rise of temperature magnetic hysteresis. ✓

[Abstracter's note: Complete translation]  
Card 1/1

S/137/61/000/011/061/123  
A060/A101

AUTHORS: Kirenskiy, L. V., Khromov, B. P.

TITLE: Investigation of the law of approach to saturation in single crystals of silicon iron

PERIODICAL: Referativnyy zhurnal. Metallurgiya, no. 11, 1961, 10, abstract 11Zh62 (V sb.: "Magnitn. struktura ferromagnetikov", Novosibirsk, Sib. otd. AN SSSR, 1960, 217 - 225)

TEXT: The investigation was carried out upon single crystal specimens of silicon Fe (3.3% Si), cut out of cold-rolled transformer steel with 0.5 mm thickness. The orientation of the crystals was determined by the Laue method. For the study, one picked crystallites whose plane [110] coincided with the plane of the sheet. After polishing the specimens were annealed for 4 hours at 1,000°C in vacuum. The investigation was carried out upon specimens cut out in the directions [100], [110], [111], [221], [443], [112]. A description of the apparatus used for the measurements is given. For the directions [100] and [111] in fields > 900 oersteds there is a linear dependence of the susceptibility  $\chi$  as a function of  $1/H$ ; a considerable part of the total  $\chi$  consists here of the sus-

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Investigation of the law of...

S/137/61/000/011/061/123  
A060/A101

ceptibility  $\chi_p$  of the paraprocess. In the law of approach to saturation a considerable role is played by the terms  $B/H^3$  and  $\chi_p$  for the specimen cut in the direction [110]. For specimens cut in the directions [221], [443], and [112], the law of approach to saturation is expressed by the formula  $\chi = B/H^3 + \chi_p$ . The  $\chi$  of the polycrystalline specimen turned out to be approximately double that of the  $\chi$  of any of the specimens investigated for the same values of the magnetic field intensity. It is concluded that the law of approach to saturation in its classical form is inapplicable to the single-crystal specimens of large dimensions.

A. Rusakov

[Abstracter's note: Complete translation]

Card 2/2

S/139/60/000/004/023/033  
E201/E591

AUTHORS: Kirenskiy, L. V. and Veter, V.V.

TITLE: Investigation of Domain Boundaries in Ferromagnetics 21

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Fizika,  
1960, No.4, pp.183-189 21

TEXT: The magneto-optical Kerr effect was used to study domain boundaries in monocrystals of silicon iron containing 3% Si. The possibility of using the Kerr effect in domain-boundary studies was pointed out by G. S. Krinchik (Ref.3). The basis of the method is the rotation of the plane of polarization on reflection of polarized light from a sample magnetized at right-angles to the surface. The coefficient of proportionality between the angle of rotation and the magnetization intensity depends on the wavelength of the light and on the temperature. The boundary-layer width is found by measuring the change in the light flux produced by rotation of the plane of polarization. The apparatus used included a microscope MBI-6, a polarizer and an analyser and a photomultiplier FEU-18. The method employed gave the thickness of the domain boundary and its polarity directly, without the use of

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S/139/60/000/004/023/033  
E201/E591

Investigation of Domain Boundaries in Ferromagnetics

magnetic powders which distort the boundaries. It was found that the polarity of the domain boundaries in silicon iron with 3% Si was variable and that the boundary layer widths were unstable: for 180° boundaries they ranged from 0.58 to 0.88  $\mu$ . There are 2 figures and 4 references: 1 Soviet, 1 German and 2 English.

ASSOCIATION: Institut fiziki Akademii nauk SSSR  
(Physics Institute, Academy of Sciences, USSR)

SUBMITTED: April 9, 1959

✓

Card 2/2

69684

S/126/60/009/03/004/033  
E111/E414

24.7900

AUTHORS: Kirenskiy, L.V., Laptey, D.A., Drokin, A.I. and  
Smolin, R.P.

TITLE: Temperature Magnetic Hysteresis<sup>21</sup> of Silicon-Iron Single Crystals

PERIODICAL: Fizika metallov i metallovedeniye, 1960, Vol 9, Nr 3, pp 337-344 (USSR)

ABSTRACT: The authors point out that although investigation of magnetic hysteresis should be carried out on single crystals, polycrystalline specimens have only been used for temperature magnetic hysteresis studies (eg Ref 1 to 3). The present authors have used single crystal 5.4 x 0.43 x 0.076 cm specimens of 3.8% Si - iron cut by etching along the principal and intermediate crystallographic directions. Crystallographic orientation was determined by the Laue method. Before measurements, specimens were vacuum annealed at 1100°C for 4 hours and cooled slowly. Measurements were carried out with a heating-cooling cycle of +50 to ⊗ to +50°C on a vertical astatic magnetometer described previously (Ref 4). Fig 1, 2 and 3 show magnetization as a function ✓

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69684

S/126/60/009/03/004/033  
E111/E414**Temperature Magnetic Hysteresis of Silicon-Iron Single Crystals**

of temperature for the  $[100]$ ,  $[110]$  and  $[111]$  directions, respectively, and for various field strengths. At low field strengths (under 1 oersted) the curves in Fig 1 have two maxima and one minimum and intersect, but they become simpler with increasing field strength and at 100 oersted hysteresis is practically absent and the curve shows a continuous fall with increasing temperature. For the other directions, fields up to 3 oersted give curves with one pronounced maximum; at higher fields (100 to 150 oersted) the curves again become simpler but even at 150 oersted a maximum remains in the curve for the  $[111]$  direction (Fig 3e). With specimens cut out along intermediate directions (15, 40 and 75° to the  $[100]$  direction) considerably different curves were obtained. Fig 4 shows the hysteresis as a function of field strength for the main directions and one for a specimen cut out at 40° to  $[100]$  (curve 4); all have a maximum. Corresponding functions for relative change in magnetization are shown in Fig 5 with an additional curve (5) for a 15° inclination to  $[100]$ ; all curves ✓

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Temperature Magnetic Hysteresis of Silicon-Iron Single Crystals

fall continuously with increasing field strength. The authors propose an explanation of their magnetization vs temperature curves on the basis of a comparison of these results with known data (Ref 7,8) on the temperature dependence of the magnetic-anisotropy and magnetostriction constants and the original domain structure. There is a discrepancy between Fig 5 and corresponding results of Baranova and Shur (Ref 9): this is attributed to differences in the alignment of the easy-magnetization axes. Fig 6 shows a series of domain structures for magnetization along  $[110]$  in fields up to 30 oersted. The authors explain the similarity between magnetization vs temperature curves for polycrystalline silicon-iron specimens with those for single crystals along  $[110]$  and  $[111]$  by the presence in the former of more crystals with these and similar directions than with  $[100]$ . The authors note that the foregoing can explain occasionally observed sharp dips in magnetization vs temperature curves. There are 6 figures and

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696814

S/126/60/009/03/004/033  
E111/E414

Temperature Magnetic Hysteresis of Silicon-Iron Single Crystals

9 Soviet references.

ASSOCIATION: Institut fiziki Sibirskogo otdeleniya AN SSSR  
g. Krasnoyarsk (Institute of Physics, Siberian Division  
of the Academy of Sciences USSR, Krasnoyarsk)

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SUBMITTED: July 1, 1959

Card 4/4

86898

24.7960 (1035, 1055, 1160)

S/056/60/039/005/015/051  
B029/B079

AUTHORS: Kirenskiy, L. V., Ignatchenko, V. A., Rodichev, A. M.

TITLE: The Behavior of a Domain Structure Under the Influence of Elastic Tensions

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 5(11), pp. 1263-1268

TEXT: Using a thermodynamic method devised by L. D. Landau and Ye. M. Lifshits the authors studied an iron-type crystallite whose surface coincided with the (001) plane. They assumed the existence of partially overlapping domains whose width can assume values between 0 and D (D denotes the width of the principal domains). In this paper, the free energy of such a structure is calculated. The coordinates are assumed to coincide with the tetragonal axes of the crystallite, and the dimensions of the crystallite along the coordinates are denoted by  $x_0, y_0, z_0$ . Using the method of Ch. Kittel (Ref. 2) for the calculation of the energy of the

magnet poles, one obtains

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$$\gamma_0 = \frac{4\omega^2 D}{\pi^2} \left[ 1.05 + \sum_{m=1}^{\infty} \frac{\cos(2m-1)\pi k}{(2m-1)^2} \right] \cdot \gamma^2(1.1)_{\gamma}$$

86898

The Behavior of a Domain Structure Under the Influence of Elastic Tensions

S/056/60/039/005/015/051  
B029/B079

where  $\omega$  denotes the surface density of the magnet poles. Moreover,  $k = d/D$ .  $f(k)$ , that is, the expansion appearing in the brackets of (1,1) was calculated by means of the tables compiled by K. A. Kitover (Ref. 11). For estimates,  $f(k) = 5.28k^3 - 6.84k^2 + 2.1$  for  $k \leq 0.5$ , and  $f(k) = 5.28k^3 - 9k^2 + 2.16k - 1.56$  for  $k > 0.5$ . If the face of the crystallite does not coincide exactly with  $[001]$ , the energy of the magnet poles is  $F_M^* = 1.7 I_s^2 \sin^2 \theta$ .  $2D/(1 + \mu^*) y_0 = aD/y_0$ , where  $\mu^* = 1 + 2\pi I_s/K$ .  $\theta$  denotes the angle between the crystallite face and the direction  $[001]$ , and  $K$  denotes the constant of magnetic anisotropy. In the principal domains and also in the closing domains there is an equilibrium state with a complicated distribution of the stress tensor. The authors assume that a deformation exists only in the direction of the x-axis, and they calculate the density of energy in the closing domains. In this case, the total free energy of the structure amounts to  $F = F_m + F_m^* + F_{m.s} + F_g + F_\sigma$ . Here,  $F_m = (8\omega^2/\pi^2 z_0) D f(k)$  denotes the energy of the magnet poles;  $f_g$  is the total

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The Behavior of a Domain Structure Under the Influence of Elastic Tensions

S/056/60/039/005/015/051  
B029/B079

energy ( $\gamma$  is the surface density of the boundary energy);  $F_{ms}$

$= c_2 \lambda^2_{100} D k^3 / 2z_0$  is the magnetostriction energy; and  
$$F_s = -\frac{3}{2} \lambda_{100} \sigma \left( \cos^2 \varphi - \frac{1}{3} \right) + \frac{3}{4} \lambda_{100} \sigma \cos 2\varphi \frac{D k^2}{z_0}$$

where  $\varphi$  denotes the angle between the stress direction and the z-axis. The second part of the present paper deals with the behavior of a structure under the influence of stress. For any value of  $\sigma$ , the equilibrium state of the structure is defined by the conditions  $\partial F(D, k) / \partial D = 0$ ,  $\partial F(D, k) / \partial k = 0$  wherefrom the equations

$$D = \left[ \frac{16 \omega^2 / 3 \pi^2}{a z_0 / \gamma_0 + 8 \omega^2 \pi^2 / (k) + c_2 \lambda_{100}^2 k^2 / 2 + 3/4 \lambda_{100} \sigma k^2 \cos 2\varphi} \right]^{1/2}$$

$$(16 \omega^2 / 3 \pi^2) / (k) + \lambda_{100}^2 c_2 k^2 + \lambda_{100} \sigma k^2 \cos 2\varphi = 0$$

follow. If there is no stress in the crystallite, one of three structures, a, b, or c, will appear, depending upon the value of  $\omega$ . If structure a is assumed to be stable, and if a uniform expanding stress is applied at an angle greater than  $\pi/4$  relative to the z-axis, closing (b) appear at a certain value of  $\sigma$ . They increase until the total closing (c) is reached. In this case, D may either increase or decrease. Then, part of the closing

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The Behavior of a Domain Structure Under the  
Influence of Elastic Tensions

S/056/60/039/005/015/051  
B029/B079

domains increases, while the other part decreases. If  $\sigma$  increases, the closing domains decrease until structure h is formed. The accompanying figure shows the consecutive stages of change in the domain structure under expansion. Ya. S. Shur and V. A. Zaykova (Ref. 7) observed also a transition from f to g. The calculations described in the present paper agree well with the known experiments and demonstrate the possible existence of structure e. There are 7 figures and 11 references: 9 Soviet and 2 US.

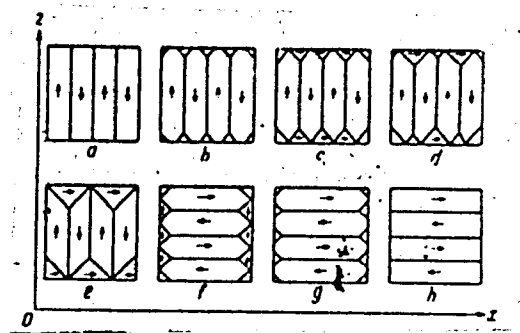
ASSOCIATION: Institut fiziki Sibirskogo otdeleniya Akademii nauk SSSR  
(Institute of Physics of the Siberian Branch of the Academy  
of Sciences USSR)

SUBMITTED: March 24, 1960

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32218

1131/01/000/004/003/

0075/E555

24,2200 (1147, 1164, 1160)

AUTHOR: Shreder, L.V., Burdakov, V.A. and Savchenko, N.

TITLE: Domain structure of thin ferromagnetic films during a magnetic field

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Fizika  
no.4, 1961, 52-55 + 5 plates

TEXT: A. S. Fowler, E.M. Fryer & Stevens (Ref.1: Phys. Rev., 104, 645, 1950) observed photographically, by means of the method of superposition, the remagnetization of domains under reverse field in films 5000, 2500 and 500 Å thick of an alloy of 20% Fe and 80% Ni. H. Williams and R. Sherwood (Ref.2: J. Appl. Phys., 33, 548, 1962) detected the configuration of domains in demagnetized films of pure metals and a number of alloys; they also described the germination and growth of domains in films of cobalt and of the alloy Fe-Ni-Mo. By the same method C.E. Butler (Ref.3: J. Phys. et. Radium, 20, No.2-3, 310-317, 1959; Discus., 317-318) investigated the process of remagnetization in films of iron (400 Å) and 20% Fe and 80% Ni (900 Å) by a magnetic field applied during the process of producing the films in direction. Card 1/4

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Domain structure of iron

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E073/E535

respectively parallel and perpendicular to the magnetic field. W. O. Zien and N. Mitchell (Ref. 1, J. Appl. Phys., 30, 251, 1959) have observed visually and photographically the speed of movement of the domain walls as a function of the changes in the direction of the field and the changes in the temperature on 1500 Å thick films of 22% Fe plus 78% Ni. They found that the speed increases with increasing temperature for a given fixed value of the applied magnetic field. The authors of this paper have studied, by means of the powder pattern method, the dependence of the domain structure on the angle between the direction of the applied field and magnetization. They found the axes of easy magnetization in the films of the alloy 80% Ni, 17% Fe and 3% Cu. They also studied the change in the domain structure during remagnetization by magnetization in magnetic fields applied at various angles relative to the axis of easy magnetization and also the change in the domain structure in a rotating magnetic field. The films were produced by thermal evaporation of an alloy of the above composition on tungsten needles (radius 17.5 μm) and on glass onto optically polished glass measuring 10 × 10 mm. The temperature was 550°C while applying a magnetic field of the order of 10<sup>4</sup> Oe. (Ref. 2/3)

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Domain structure of thin ...

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E073/E535

The direction of the field was the same as the plane of the film. Each time the alloy from the crucible evaporated completely. The direction of easy magnetization of the films coincided with the direction of the field at the instant of deposition. The following conclusions are arrived at:

1. In most cases no domain structure was observed without preliminary demagnetization in Fe-Ni-Mo alloy films, obtained by evaporation in vacuum in the presence of a magnetic field in the same direction as the film plane. The appearance of the domain structure after demagnetization of the films depends to a great extent on the direction of the demagnetizing field relative to the axis of easy magnetization. When the angle is increased, the number of boundaries and the domains become narrower.
  2. Within a considerable range of fields the domain structure remains stable for demagnetized films. A further increase in the field within a narrow interval brings about changes in the domain structure; if the films are sufficiently thick (2600 Å), the change in the domain structure is accompanied by a displacement of the boundaries, in the same way as in massive ferromagnetic crystals. In thinner films almost no displacement of the
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Domain structure of thin ...

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boundaries is observed and fracture occurs. It is attributed to the sudden remagnetization of considerable parts of the domains, which are not suitably oriented relative to the field. Such a remagnetization is apparently due to a sudden rotation of the magnetization vector in the section being remagnetized. There are 4 figures and 5 references: 1 Soviet and 4 non-Soviet. The English-language references are quoted in the text.

ASSOCIATION: Institut fiziki SO AN SSSR, Krasnoyarskiy pedinstitut (Physics Institute SO AS USSR, Krasnoyarsk Pedagogic Institute)

SUBMITTED: July 20, 1960

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32223

S/139/61/000/004/016/023

E052/E314

14,7700 (1136, 1160, 1164)

AUTHORS: Zagoryanskaya, Ye.V. and Kireyev, P.S.

TITLE: Determination of the optical constants of thin films  
by interferometric methods

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy Fizika  
no. 4, 1961, 124-133

TEXT: The present authors report an analysis of the effect of interference on absorption measurements. It is shown that interference patterns can be used in the rapid determination of the reflection coefficient, the refractive index, the absorption coefficient, the phase change on reflection and the frequency dependence of all these quantities. The authors look upon a thin film as a Fabry-Perot element and derive a general expression for the transmitted intensity by summing-up the multiply-reflected waves in the usual way. The general analysis is then applied to a) non-absorbing films, b) absorbing films, and c) films deposited onto a glass base. Formulae are derived which can be used in conjunction with measurements on the interference patterns in order to deduce the optical constants of thin films.

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